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Analysis of Changing Methods of Vertical Coordination in the Pork Industry

Steve W. Martinez, Kevin E. Smith, and Kelly D. Zering

ABSTRACT

This study examines the motivation behind contracts and vertical integration in the pork industry, and simulates the effects of potential improvements in coordination. Incentives related to lowering costs of measuring and sorting hogs, and protecting against opportunistic behavior associated with specific assets, can result in hog quality improvements. A framework for simulating the effects of increased coordination through contracts and vertical integration was developed and used to evaluate potential improvements in leanness. Although simulations suggest only modest changes in pork prices and supplies, gains in consumers' surplus could be substantial for larger demand shifts due to quality improvements.

Key Words: contracts, hogs, lean pork, simulation model, vertical coordination, vertical integration.

Significant changes underway in the pork industry illustrate the industrialization of agriculture (Hurt; Boehlje; Rhodes). The trend toward larger, more specialized hog production and processing operations is accelerating (Hurt). Potential size economies and new health-enhancing technologies encourage greater concentration of animals. Changing methods of vertical coordination in the pork industry are also evident. The proportion of slaughter hogs obtained by large packers through long-term contracts or integrated operations is expected to increase from approximately 13% in 1993 to 34% in 1998 (Hayenga et al.).

Greater use of contracting and integration has led to complaints by smaller hog producers and packers about market power. Market power through price discrimination, or barriers to entry, may result in welfare losses to society because of misallocated resources. Contracting and integration also reduce the amount and accuracy of publicly available market information, which may distort production and marketing decisions of producers.

However, contracting and integration may also result in improved food quality for consumers. As households have become smaller and the value of their time has increased, consumers place a greater value on convenience and quality assurances in their food purchases. Information linking diet to health has increased consumer interest in the nutritional quality of food products. Trends toward more away-from-home food consumption and in-

Martinez is an agricultural economist with the Economic Research Service, U.S. Department of Agriculture. Smith is a Ph.D. candidate and Zering is an associate professor/extension specialist, both at North Carolina State University.

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creased sales by large restaurant chains indicate that food suppliers must be able to provide large amounts of consistently high quality, uniform products. Pork producers and processors also are introducing branded products, thereby increasing the need for quality control. Contractual arrangements and vertical integration presumably are leading to a highly coordinated pork marketing system which is more responsive to consumer preferences. In a 1993 survey, large packers ranked "improved quality" as the most important reason for market contracts (Hayenga et al.). By tying premiums and discounts paid to the quality of hogs produced, or by directly controlling quality, packers may receive a more consistent supply of high quality hogs. Hence, it is important to consider benefits of changing coordinating arrangements, as well as potential harmful effects related to market power.

Unfortunately, there is very little empirical work that examines the market effects of changing methods of vertical coordination.[1] Yet, limited empirical evidence suggests that these effects could be substantial. For example, Kinnucan and Nelson use a farm-retail price margin model of the egg industry to examine the effect of increased vertical control on marketing costs. They estimated that contract production reduced egg marketing costs by 25% between 1973 and 1983. In a competitive egg marketing system, this translates into lower egg prices on retail shelves for a given level of demand. Similar results have been documented for nonfood industries as well. Kwoka estimated that vertical integration of the generation and distribution stages of the U.S. electric utility industry led to cost savings of 27%. Hence, consumers and producers have an interest in the type of coordinating arrangements that develop.

In this analysis, we focus on the reduction of transactions costs associated with quality improvements as incentives for contracts or vertical integration between hog producers and packers. We present a modeling framework for simulating the impact on the pork industry of a hog market characterized by a combination of open market exchange, contract coordination, and vertical integration. We then evaluate the potential effects of quality enhancements (i.e., increased leanness) via contracts and vertical integration.

Motivating Forces for Changes in Coordination Between Producers and Packers

We focus on transactional economies as motivation for contracts and vertical integration, specifically those that relate to improvements in quality. Transactions costs are expenses associated with carrying out transactions, such as measuring performance, creating incentives, and enforcing agreements to ensure desired performance. Transactions cost theory suggests that economic activity is organized to minimize these costs (Milgrom and Roberts). Hence, the move to contracting or vertical integration may be occurring to reduce the costs of trading on the open market. By reducing transactions costs associated with obtaining higher quality hogs, the quality of hogs may be improved.

Measuring and Sorting Costs

One way that non-spot coordinating arrangements can improve the quality of hogs slaughtered is by reducing transactions costs associated with asymmetric information and monitoring between packers and producers. A buyer of an intermediate product (input) may have difficulty in assessing the quality of the product. For example, the PSE (pale, soft, exudative) pork quality problem in some pork carcasses is not easy to identify in carcasses at the time of grading. Barzel argues that to judge the value of a good, its attributes must be measured. The cost of measuring these attributes may be expensive and mistakes in measurement may result in wealth transfers. In addition, if there exists some variability in desirable attributes of the intermediate product, it may require costly sorting to determine its

[1] Formal empirical modeling of non-spot coordinating arrangements has focused on higher profits as incentives for vertical integration of imperfectly competitive stages (e.g., Azzam; Azzam and Wellman).

value. The total cost of the good to the buyer is the price paid plus the cost of attribute measurement. If the quality attributes can be controlled in the production process, the buyer of an intermediate product may reduce the costs of measuring and sorting by using new methods of coordination with the producer.

In the pork industry, the characteristics of the hogs used by the packer and processor can have an important influence on production costs and the value of the final output produced. These characteristics include leanness, PSE, and hog size. For example, Forrest found a 53% lean hog to be worth approximately $13 more than a 45% lean hog.

Since the value of hogs is largely determined by genetics and weight of hogs received, the use of long-term contracts by the packer, which specify these characteristics, may help reduce measurement and sorting costs. As the costs of measuring quality attributes of hogs increase, the cost of monitoring contractual performance in long-term contracts also increases. This increases the incentive for vertical integration, as opposed to long-term contracts.

Hennessy presents a model demonstrating that inaccuracies in measuring the quality of an intermediate agricultural product create incentives for contracts or vertical integration. If information asymmetries exist between producers and processors regarding the quality of the intermediate product, testing is required by the processor to determine the appropriate premium. Inaccuracies in testing of product quality reduce the incentive for producers to invest in assets that improve quality (e.g., genetic stock, technical education, harvesting and storage equipment, etc.). Contracts and vertical integration and production contracts solve the problem by removing the need to test for quality, thereby improving the quality of the intermediate input.

Asset Specificity

Another incentive for vertical contracting and vertical integration may be created by the use of specific assets in the production process of intermediate goods (Klein, Crawford, and Alchian). Specific assets are assets whose value is much greater in a particular use compared to the next-best alternative (Milgrom and Roberts). A specific asset may be physical (unique physical characteristics), human (unique skills), or site (unique location) specific capital.

Klein, Crawford, and Alchian suggest that specific assets may generate quasi-rent streams, where quasi-rents are defined as the value of the asset in excess of the salvage value (i.e., next-best alternative use). These quasi-rents may be appropriated through the opportunistic behavior of others. For example, an individual contemplating investment in a specific asset may agree to exchange with another party at prices that will ensure the owner receives some level of quasi-rent from the specific asset. Once the investment is made, the second party may then renege on the agreement by offering a lower price. The owner may be forced to accept the offer, as long as the price is more favorable than could be obtained in the next-best alternative use.

Long-term contracts and vertical integration serve to protect individuals from opportunism by trading partners. A large number of studies have found that as the level of appropriable quasi-rents increases, the use of long-term contracts and vertical integration increases (see Shelanski and Klein for a review of the literature).

The use of long-term marketing agreements may serve to reduce the potential for opportunism in the development of pork products with unique quality characteristics. For example, PSE pork is lower in quality and highly related to the "stress gene." The National Pork Producers Council (NPPC) estimates that PSE costs packers $3.29 per hog, with PSE affecting over 10% of U.S. hogs (Morgan et al.). Packers may reduce these costs by offering premiums to hog producers who use genetic lines that are free of the "stress gene." Carcass merit pricing schemes used in spot markets offer no premiums for hogs bred from genetic lines that are free of the "stress gene." In order to receive premiums, hog producers may need to make substantial investments in "stress gene" free breeding stock (physical specific assets). Once

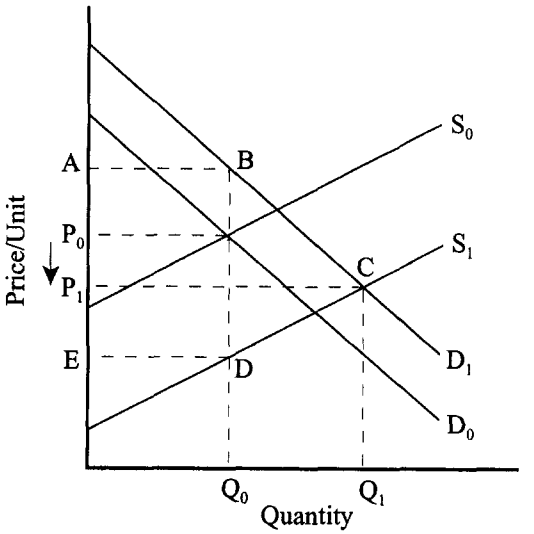

Figure 1. Net effect at the retail stage of increased vertical coordination of the pork production and packing stages

the investment is in place, the premium over the spot market price becomes a quasi-rent that can be appropriated to the packer. If the packer lowers the premium offered, the producer is left with the alternative of accepting the reduced premium or selling in the spot market for no premium at all. A legally enforceable long-term contract with specific quality provisions provides protection against short-term opportunism. As the level of appropriable quasi-rents increases, the likelihood of vertical integration increases because there is a greater one-time benefit of reneging on a long-term contract.[2]

Price, Quantity, and Economic Surplus Changes

The expected market impact of reducing transactions costs associated with quality improvements is illustrated in figure 1. At the initial equilibrium, the retail price is P_0 and retail quantity is Q_0. Now consider packers and producers who establish contracts for delivery of finished hogs, or vertically integrate. Higher quality hogs, manifested in quality improvements of pork products, shift out the demand for pork from D_0 to D_1 (Unnevehr). Improving the quality of hogs also reduces slaughter and processing costs by increasing the productivity of the hogs. This shifts the retail supply curve from S_0 to S_1. The shifts in supply and demand result in a new equilibrium at Q_1 and P_1. The new equilibrium quantity is unambiguously larger. The net effect on the retail price is indeterminant, depending on the elasticities of supply and demand and on the extent of the horizontal shift-out in supply and demand. In figure 1, the shift-out in supply exceeds that of demand, so that the retail price falls. Assuming parallel shifts in supply and demand, there is a consumer surplus gain equal to the area $ABCP_1$, and a gain to producers equal to the area P_1CDE (Lemieux and Wohlgenant).[3]

Modeling the Effects of Increased Coordination

Kilmer and Ward have offered one of the few frameworks for simulating the effects of increased coordination of the vertical stages of a competitive marketing system. They hypothesize that when a firm contracts or integrates to obtain inputs, parameters of the production function may be altered because of increased input productivity. This occurs because the input is usable only within a narrow band of characteristics, such as quality, quantities, and timing of deliveries, which can be controlled with greater precision by using non-spot coordinating arrangements. To obtain an aggregate market supply curve in a market consisting of firms that use non-spot exchange methods and firms that exchange on the open

[2] Other examples of specific assets in the pork industry include substantial investments necessary to take advantage of economies of size in hog production (e.g., feed mills, confinement housing, etc.) and hog processing (e.g., packing plants, storage facilities, etc.).

[3] The equivalence of these areas to changes in consumer and producer surplus can be derived using geometry, assuming parallel shifts in supply and demand. Producer surplus represents net benefits because the formula aggregates over all producers, when only a fraction of pork may be affected by non-spot coordinating arrangements. Therefore, winners and losers from non-spot coordinating arrangements are not sorted out.

market [i.e., multiple exchange mechanism (MEM) market], firm supply curves for the more productive firms and less productive firms were summed. The importance of contracting and integration is reflected by the proportion of firms using these methods of coordination. Equilibrium prices and quantities in the MEM market are then compared to equilibrium in a market consisting only of spot market exchanges.

A major weakness of the Kilmer and Ward framework relates to estimation of parameters of the production function for firms that contract or integrate. According to Kilmer and Ward, parameters can be directly estimated in industries that have undergone changes in vertical coordination, or they can be approximated using managerial judgment. However, direct estimation would be difficult because it is unlikely that changing methods of coordination in the pork industry have been significant enough to warrant direct estimation. To the extent that such changes have occurred, it would be difficult to attribute differences in parameter estimates to changing methods of coordination. It is also unlikely that "managerial judgment" can be used to indicate how a parameter in a production function changes with new methods of vertical coordination.

The framework used here differs from that of Kilmer and Ward in several ways. First, we account for demand shifts at the retail level due to food quality improvements. Second, Kilmer and Ward focused on farm-stage effects, whereas we additionally examine effects at the retail level, since changing methods of coordination can have important implications for consumers as well. Finally, we use percentage of hog sales through contract production or vertical integration to reflect their importance in the pork industry, instead of the proportion of firms that use these arrangements. This is because firms can use several methods of coordination at the same time.

To evaluate the price and quantity effects of increases in vertical coordination between the hog production and packing stages, we use the modeling framework developed by the National Pork Producers Council, Agricultural Education and Consulting Team (Sonka, Doehring, and Hofing). The NPPC model is a comparative statics model with two inputs (hogs and marketing services) and one product (pork), consisting of three competitive stages (retail, marketing, and farm). Hog quality improvements resulting from increased coordination are represented in the modeling framework as a shift in supply and demand. We follow the methodology used by Sonka, Doehring, and Hofing for estimating supply and demand shifts related to improved pork quality. We estimated shifts in retail demand related to increased leanness, and shifts in retail supply related to increased leanness, and lower hog acquisition costs. Reduction in the "fatness" attribute was examined because more information exists regarding consumer preferences for leaner pork compared to other quality attributes, such as PSE (Sonka, Doehring, and Hofing).

Vertical Coordination and Improved Leanness

The relationship between non-spot coordinating arrangements (i.e, contracts and vertical integration) and reductions in fat is inferred using survey results and firm-level cases. In a 1993 survey of the 19 largest pork packers, each was asked to give primary reasons for using long-term contracts (Hayenga et al.). Seven of the 10 respondents ranked improved quality as the most significant reason. In addition, half of all long-term contracts between the large packers and large hog producers included minimum quality or genetics requirements.

Smithfield Foods, a leading packer in the pork industry, emphasizes the importance of long-term contracts and vertical integration in obtaining consistent supplies of lean, high quality hogs (Smithfield Foods, Inc.). In fiscal year 1996, it obtained approximately 61% of its hogs through long-term agreements and integrated operations. Smithfield Foods touts its National Pig Development (NPD) program as the best demonstration of the effects of a highly coordinated operation. Through Smithfield-Carroll's, a joint hog production operation with a major North Carolina hog producer,

Table 1. Packer Costs Associated with Leanness Problems

Packer Defect	Controllable Costs ($/head)	Cost Controlled by Farmer (%)
Backfat thickness	2.80	100
Degree of ham and butt trimming	1.87	100
Excessive seam fat	0.63	100
Bellies too fat or too thin	0.14	100
Weight problems	0.88	100
Total packer costs	6.32	

Source: Sonka, Doehring, and Hofing.

Carroll's Foods, Smithfield Foods has long-term contracts with Carroll's and its affiliates to raise hogs. Smithfield-Carroll's also obtained exclusive rights to develop and market the NPD breed of hog. This breed produces the leanest hog in U.S. commercial production and one of the leanest meats of any kind, including chicken. Nutritional studies in 1996 indicated that NPD pork is 34% to 61% leaner than that of non-NPD pork, depending on the cut. Other packers using non-spot coordinating arrangements include Farmland Foods and Excel, who offer contracts with specific requirements regarding leanness (Freese, Fee, and Looker).

Supply Shifts

Sonka, Doehring, and Hofing estimated that packers could save $6.32 per head by slaughtering a hog that is approximately 19% leaner than average (table 1).[4] Because packer costs associated with leanness problems were reported to be controlled at the farm stage (e.g., through genetics), these cost savings could be realized by increased coordination between the producer and packer. Coordination via contracts or integration can serve to improve the quality of hogs slaughtered by reducing measuring and sorting costs or by reducing opportunism associated with investments in specific breeding stock. Smithfield Foods' NPD program suggests that a 19% reduction in fat from increasing vertical control through contracting or integration is realistic.

To estimate the shift in the retail supply curve associated with the production of leaner hogs, the $6.32 per head cost reduction is first multiplied by the average number of U.S. federally inspected barrows and gilts slaughtered from 1993–95 (89.7 million head) [U.S. Department of Agriculture (USDA), *Livestock Slaughter*]. Dividing this cost of excess fat ($567 million) by average total marketing costs of $19.8 billion[5]—which include costs such as slaughtering and processing, transportation, and cutting and merchandising—gives potential marketing cost savings of 2.86%.

Assuming that increased leanness is achieved through contracting and integration, another potential source of cost savings is hog acquisition costs. These costs include operating buying stations, paying salaried or commissioned buying agents, and transporting hogs to packing facilities. Recently, Thorn Apple Valley entered into an agreement with the Michigan Livestock Exchange (MLE) to manage the company's buying stations and to supply the quantity and quality of hogs specified by Thorn Apple Valley. Thorn Apple Valley pays MLE $83,333 a month plus MLE's hog costs to supply approximately 2.1

[4] This percentage reduction was calculated by comparing a weighted average of backfat depth for packers in the survey and comparing it to the mid-point of the optimal backfat depth range of 0.8 to 1.0 inch. Specific assumptions regarding the weight of the leaner hogs are not necessary to estimate the shifts in supply due to packer cost savings.

[5] The average of total marketing costs from 1993–95 was calculated by first estimating average farm revenue over the same period. Average farm revenue ($10.3 billion) was calculated by multiplying average quantity of pork sold (liveweight billion pounds; USDA, *Meat Animals—Production, Disposition, and Income*) by average farm price ($/pound; USDA, *Hog Outlook*). Average consumer expenditures ($30.1 billion) were then estimated by dividing average farm revenue by the average cost share of farm inputs (0.34, net farm value as a percent of retail price; USDA, *Hog Outlook*). That is, consumer expenditures are 1/0.34 times higher than farm revenue. Average marketing costs ($19.8 billion) are then calculated by subtracting average farm revenue from average consumption expenditures.

million hogs per year (Martinez, Smith, and Zering). This results in a cost of $.48 per hog for acquisitions (not including transportation or buying station facilities costs). Packers producing their own hogs, or using long-term contracts, do not incur this buying station management fee.

U.S. hog slaughter of 89.7 million head, together with a $.48 per hog reduction in buying agent costs, suggests that hog acquisition cost savings ($.48 × 89.7 million head = $43 million) as a percentage of total marketing costs ($19.8 billion) are 0.22%.[6] Adding this to packer cost reductions due to increased leanness, the net percentage change in marginal cost is $-(2.86 + 0.22)\alpha = -3.08\alpha$, where α is the percentage of market hog sales through long-term contracting and vertically integrated operations. Percentage shifts are adjusted down to reflect the degree of contracting and integration in the hog industry. A similar approach was used by Lemieux and Wohlgenant to reflect adoption rates of a growth hormone.

Demand Shifts

The shift in the demand for pork arising from a 19% reduction in fat is calculated using consumer premiums placed on leaner pork. Because an estimate of consumers' value of leaner pork could not be located,[7] the premium placed on 19% leaner pork was derived using consumers' willingness to pay for 10% leaner pork. Lemieux and Wohlgenant used survey data to estimate consumers' willingness to pay for 10% leaner pork that is produced by a growth hormone. They found that mean willingness to pay for this 10% leaner pork was 4.3% of the retail price. Using a linear interpolation of consumers' willingness to pay for 10% leaner pork, we estimate that consumers' willingness to pay for 19% leaner pork is 8.2% of the retail price of pork.[8] Assuming that the willingness to pay for leaner pork applies only to fresh pork, which comprises 25% of total pork consumption (Sonka, Doehring, and Hofing), the percentage demand shift is estimated to be 2.0α (i.e., $8.2 \times 0.25\alpha$), where α reflects the degree of contracting and integration.

We use three estimates of the degree of contracting and integration in the pork industry. Hayenga et al. surveyed 19 large packers in 1994, accounting for 86% of U.S. hog slaughter in 1993. Their results indicated that contracting and integration accounted for about 13% of their market hog transactions in 1993, and were projected to increase to 34% by 1998. Assuming that packers who were excluded from the survey (14% of U.S. slaughter) did not procure their hogs using these arrangements, then on a national basis these arrangements accounted for about 11% (0.86 × 0.13) of U.S. packers' supply, with 1998 projections to 29% (0.86 × 0.34). For comparison, simulations also are provided for the case where 100% of hogs are transferred through contracts and integrated operations.

Results

Changes in prices and quantities from increased coordination considered in our analysis are presented for nine scenarios. Given the uncertainty underlying consumers' willingness to pay for leaner pork, we assume three values for the demand shift. First, we assume that there is no quality-induced demand shift due to increased coordination. Second, the willingness-to-pay estimate is applied only to fresh pork. Third, we assume that the premium placed on leaner pork applies to both fresh and

[6] Although moves to contracting or integration may not benefit Thorn Apple Valley specifically, these costs do provide documentable evidence of acquisition costs for open market purchases.

[7] Although available evidence suggests a negative relationship between fat (backfat and seam fat) in beef cuts and prices at retail (Unnevehr and Bard), similar detailed studies for pork could not be located.

[8] This estimate is based on consumers' willingness to pay for leaner pork produced from a growth hormone at a particular point in time. Consumers' willingness to pay for leaner pork may vary for leanness obtained through genetic advances, or over time as consumer preferences change.

Table 2. Changes in Pork Prices and Quantities from Increased Coordination of Production and Packing Stages

Variable	Length of Run	11% Contracting or Integration			29% Contracting or Integration			100% Contracting or Integration		
		No Value	Low Value	High Value	No Value	Low Value	High Value	No Value	Low Value	High Value
		Percent								
Retail Pork Price	SR	−0.2	−0.1	0	−0.5	−0.4	0.1	−1.8	−1.2	0.4
	IR	−0.2	−0.2	−0.1	−0.6	−0.05	−0.3	−1.9	−1.7	−1.1
	LR	−0.2	−0.2	−0.2	−0.6	−0.6	−0.6	−2.0	−2.0	−2.0
Pork Consumption	SR	0.1	0.2	0.6	0.3	0.6	1.5	1.2	2.1	5.1
	IR	0.1	0.3	0.7	0.4	0.7	1.8	1.3	2.5	6.1
	LR	0.1	0.3	0.7	0.4	0.8	1.9	1.3	2.6	6.6
Hog Price	SR	0.1	0.3	0.7	0.2	0.7	2.0	0.7	2.3	7.0
	IR	0	0.1	0.3	0.1	0.3	0.8	0.3	0.9	2.6
	LR	0	0	0	0	0	0	0	0	0
Hog Production	SR	0	0.1	0.3	0.1	0.3	0.8	0.3	0.9	2.8
	IR	0.1	0.2	0.5	0.1	0.5	1.4	0.5	1.6	4.7
	LR	0.1	0.2	0.7	0.2	0.6	1.7	0.6	1.9	5.9

Notes: SR refers to the short run (one-year adjustment), IR refers to the intermediate run (five-year adjustment), and LR refers to the long run (when supply elasticity of hogs is infinite). For the "no value" scenario, no demand shift is assumed. For the "low value" scenario, consumer willingness to pay for leaner pork is applied only to fresh pork, which implies a shift in consumer demand of 2%. For the "high value" scenario, consumer willingness to pay for leaner pork is applied to all pork, implying an 8.2% shift in consumer demand for pork. In each scenario, supply and demand shifts are applied only to the percentage of slaughter hogs procured through long-term contracts or integrated operations.

processed pork.[9] For each of the demand shifts, we generate results for three degrees of contracting and integration. Parameter values used in the simulations are presented in appendix table A1.

Effects of increases in coordination that result in improved leanness are presented in table 2 for three lengths of run, depending on the elasticity of hog supply. There is a tendency for retail prices to fall, hog prices to rise, and production and consumption quantities to rise. Changes in prices and quantities are magnified as the percentage of hogs obtained through contracts and vertical integration increases. The shift in demand due to leaner pork moderates the reduction in retail price that results from marketing cost reductions. The greater the value placed on leaner pork, the less the reduction in retail price and the greater the increase in hog price. Over a one-year period, the retail price increases when the demand shift is greatest. Price changes, however, become less sensitive to demand shifts over time as hog production and consumption rise.

These results suggest that significant benefits to producers and consumers occur through increased coordination between hog producers and packers. Changes in consumers' and producers' surplus are presented in table 3. Consumers' surplus increases over time, while producers' surplus declines. Increases in consumers' surplus range from $60 million to $3.2 billion because of increases in coordination to improve leanness. Producers' surplus is estimated to increase from $8 million to $706 million in the first year, and between $3 million and $270 million within a five-year period. These surplus changes compare to $30 billion in average total consumer expenditures

[9] Accounting for other quality attributes, such as reduction in PSE, would have the same directional effect on the size of the demand shift as applying the premium to a larger proportion of pork. In this way, applying the premium to both processed and fresh pork can be used to represent a higher willingness to pay for higher quality pork.

Table 3. Changes in Consumers' Surplus (as a percentage of pork expenditures) and Producers' Surplus (as a percentage of farm revenue) from Increased Coordination of Production and Packing Stages

Variable	Length of Run	11% Contracting or Integration			29% Contracting or Integration			100% Contracting or Integration		
		No Value	Low Value	High Value	No Value	Low Value	High Value	No Value	Low Value	High Value
		Percent								
Consumers' Surplus	SR	0.2	0.4	0.9	0.5	1.0	2.3	1.8	3.3	8.0
	IR	0.2	0.4	1.0	0.6	1.1	2.8	1.9	3.8	9.6
	LR	0.2	0.5	1.1	0.6	1.2	3.0	2.0	4.1	10.6
Producers' Surplus	SR	0.1	0.3	0.8	0.2	0.7	2.0	0.7	2.3	7.1
	IR	0	0.1	0.3	0.1	0.3	0.8	0.3	0.9	2.7
	LR	0	0	0	0	0	0	0	0	0

Note: See footnote to table 2.

on pork from 1993–95, and $10 billion in average farm revenue from hog production over the same period. Resulting changes in consumers' and producers' surplus appear to be sensitive to both the percentage of hogs obtained through contracts and vertical integration, and the shift in demand due to the production of leaner pork.

Limitations

Our ability to formally test the hypotheses regarding motives for contracting and integration was limited by a dearth of published information in several areas. Published firm-level data on contracting and integration, quality of plant slaughter output, and uniformity of hogs and pork products are sporadic, at best. The authors also are not aware of published output quality information for packers. Costs associated with contracting and integration were excluded because of the difficulty in obtaining this information. Including these costs would moderate the downward shift in the retail supply curve.[10] In addition, information on consistency of size and quality, and its effect on slaughter costs and returns would provide more accurate assessments.

[10] Because contracts are long term and between larger producers and packers, costs of negotiating and renegotiating contracts are reduced.

Estimating pork price and consumption effects of higher quality products is further complicated by the considerable uncertainty surrounding consumer valuation of pork quality attributes. For example, there is still little known about how consumers value leaner pork. This information can be assessed in several ways. Detailed price, quantity, and quality data are required to estimate hedonic demand functions for products of various levels of quality. Unnevehr and Bard directly estimated values of various types of fat in several cuts of beef using data from the National Beef Market Basket Survey. They found that external fat reduced value, while the effect of marbling was positive in some cuts and negative in others. In the absence of such data, researchers have used willingness-to-pay data to estimate the relative value of products of various levels of quality. Willingness-to-pay data usually are elicited by offering various qualities of similar products to individuals and asking them to state how much they would pay for one versus another. Estimation problems are exacerbated by the fact that "quality" may be defined by several traits rather than just one. Collection of willingness-to-pay data is expensive, and the cost increases rapidly with the number of variables being evaluated. Willingness-to-pay data are useful in estimating the direction and scale of consumers' preference, but extrapolation and assumptions are required to predict overall demand shifts.

Conclusions

The effects of contracting and integration on consumers and producers ultimately will depend on the motives for these arrangements. Transactions costs economics suggests that contracts and integration may serve to improve product quality in two ways. First, measuring and sorting costs associated with obtaining a uniform supply of high quality hogs for slaughter may be reduced. Second, opportunism associated with breeding stock for producing high quality hogs may be alleviated.

A framework was developed for assessing the effects of quality improvements due to new coordinating methods. It was then applied using the quality attribute "leanness." Significant benefits to producers and consumers can be obtained by increases in coordination between producers and packers that result in leaner hogs and pork products. Considering other attributes besides leanness could result in even greater benefits.

Potential benefits of contractual arrangements and integration, motivated by efforts to improve product quality, should be considered in legislative decisions regarding market power. Pork price increases at retail are not necessarily indicative of anticompetitive behavior. Demand shifts due to food quality improvements can result in higher retail prices, depending on the extent of quality improvements and the value placed on quality attributes.

Additional information is needed to more formally link changing methods of coordination to hog quality improvements, and link hog quality improvements to cost reductions throughout the marketing system. Possibilities for measuring quality effects of increased coordination include: a multi-firm study for a single industry, where quality of product is compared to degree of coordination; and a multi-industry study where change in product price and quality over time are compared to the degree of coordination in each industry.

Data and methodological problems include finding an appropriate definition of quality and obtaining cost and quality information that is proprietary in nature. One possibility is to undertake research projects with cooperatives, such as Farmland, or private firms, without identifying participants. Another alternative is to conduct industry-sponsored studies where firms may be more willing to participate with the intent of improving overall standards and competitiveness in the industry. Packer surveys, such as that conducted for the National Pork Producers Council (Morgan et al.), are steps in the right direction for developing a better understanding of the cost effects of quality improvements that result from increases in vertical coordination. For multi-industry studies, the challenge is to obtain comparable measures of quality and costs.

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Table A1. Parameter Values for the U.S. Pork Industry

Parameters	Values
Elasticity of demand at retail	−0.65[a]
Elasticity of supply of hogs	0.40, 1.8, ∞[a]
Elasticity of substitution	0.35[a]
Farm operator's cost share	0.34[b]
Cost share of marketing input	0.66[b]
Decrease in marketing costs[c]	−0.34, −0.90, −3.08
Increase in retail demand price[d]	0.0, 0.0, 0.0; or 0.23, 0.60, 2.0; or 0.91, 2.39, 8.2
Consumer expenditures	$30.1 billion[e]

[a] *Source:* Lemieux and Wohlgenant.

[b] *Source:* USDA, *Hog Outlook.*

[c] Percentage change in costs of −3.08% is multiplied by 0.11, 0.29, and 1.0, which correspond to three percentages of market hogs procured through non-spot arrangements.

[d] For the first three values, no demand shift is assumed. For the next three values, percentage change in consumer demand for pork of 2% is multiplied by 0.11, 0.29, and 1.0, which correspond to three percentages of market hogs procured through non-spot arrangements. For the final three values, percentage change in consumer demand for pork of 8.2% is multiplied by 0.11, 0.29, and 1.0.

[e] See text footnote 5 for derivation.